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(54) ALUMINUM ALLOY PRODUCT

ALUMINIUMLEGIERUNGSPRODUKT

ALLIAGE D'ALUMINIUM

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Description

[0001] This invention relates to an aluminum alloy product, and more particularly to aluminum alloy products developed for aerospace applications.

[0002] Nearly all commercial airplanes have fuselage skins made of Alclad 2024-T3. The base metal, 2024-T3 sheet, has the necessary strength and damage tolerance for aerospace applications, but suffers from susceptibility to pitting and/or intergranular corrosion attack. To compensate for that problem, the base metal is effectively isolated from the environment by a cladding layer, a paint or coating system or a combination of both.

[0003] An alcladding process involves combining a thin layer of an aluminum alloy anodic relative to 2024-T3 on both sides of 2024-T3 sheet. These layers act as a barrier and also afford galvanic protection to the 2024-T3 in case the cladding is damaged. In cases where these layers are intentionally removed by machining or chemical milling to save weight, 2024-T3 sheet may be protected with coatings and/or by anodization.

[0004] While the above protection systems are generally effective, they have some notable disadvantages. The Alclad layer contributes little with respect to strength, adds weight to the sheet and can act to initiate fatigue cracks. Other coating systems may also add weight and, if damaged, fail to protect 2024-T3 base metal. Surfaces that are anodized are brittle and can act to initiate cracks. Another disadvantage of 2024-T3 sheet is its relatively high density (0.101 lb/in^3).

[0005] V.I. Lukin: "Effect of Sc, Mn, Zr alloying elements on the weldability of Al-Mg-Sc-Mn-Zr system alloys," SVAR. PROIZVOD., vol. 6, 1996, discloses an alloy composition comprising 6.3 wt % of magnesium with 0-0.08 wt % scandium which increases the welded joint strength.

[0006] It is a principal interest of this invention to provide a damage tolerant aluminum alloy product useful for airplane application including fuselage skin, the lower wing sections, stringers and/or pressure bulkheads. The alloys of this invention have a relatively low density, good corrosion resistance and a good combination of strength and toughness so as to obviate cladding, painting and/or other base metal protection systems.

[0007] It is another main interest of this invention to provide an aluminum alloy product for damage tolerant applications, such as fuselage skins, that has sufficient strength primarily generated through strain hardening of a generally uniform matrix composition, as opposed to precipitating particles that are electrochemically different from the matrix as in 2024-T3 aluminum.

[0008] It is still a further interest of this invention to provide a lower density alloy than 2024-T3 aluminum for potential weight savings in commercial aircraft. With a lower density alloy, increased fuel efficiency and/or increased payload capacity will result. It is yet another object to provide an aluminum alloy system that retains superior performance over the long (generally 20 to 40 year) life of commercial aircraft. It is also an interest of this invention to provide such a material with improved resistance to fatigue crack initiation.

[0009] According to the invention, there is provided an aluminum alloy product comprising an alloy composition consisting essentially of 3.5-6 wt % magnesium, 0.03-0.2 wt % zirconium, 0.2-1.2 wt % manganese, up to 0.15 wt % silicon, 0.16-0.34 wt % scandium, 0-0.25 wt % copper, and optionally 0.05-0.5 wt % of a dispersoid-forming element selected from erbium, yttrium, gadolinium, holmium and hafnium, the balance being aluminum and unavoidable impurities. The dispersoid-forming element is scandium. This alloy composition is also preferably zinc-free and lithium-free.

[0010] For the description of alloy compositions that follows, all references are to weight percentages (wt %) unless otherwise indicated. When referring to any numerical range of values, such ranges are understood to include each and every number and/or fraction between the stated range minimum and maximum. A range of about 0.05-0.5 wt % scandium, for example, would include all intermediate values of about 0.06, 0.07, 0.08 and 0.1 wt % all the way up to and including about 0.48, 0.49 and 0.4995 wt % scandium. The same applies to the other elemental ranges set forth below.

[0011] The term "substantially free" means having no significant amount of that component purposely added to the alloy composition, it being understood that trace amounts of incidental elements and/or impurities may find their way into a desired end product.

[0012] The alloys of the invention are based on the Al-Mg-Sc system and are of sufficient corrosion resistance so as to obviate cladding or other protection systems. Strength in these alloys is primarily generated through strain hardening of a metal matrix which is generally uniform in composition. Combinations of strength and damage tolerance properties sufficient for fuselage skin applications can be obtained by an appropriate selection of composition, deformation processing and subsequent stabilization treatments.

[0013] It has been found that the Al-Mg-Sc alloy materials of this invention display adequate tensile strength properties and toughness indicators together with excellent resistance to intergranular (or grain boundary) corrosion. These materials, also demonstrate good resistance to exfoliation attack and excellent stress corrosion cracking ("SCC") resistance during alternate immersion in an NaCl solution tested according to ASTM G-47.

[0014] A principal alloy used in this invention comprises an alloy composition which includes an aluminum alloy product comprising an alloy composition consisting essentially of 3.5-6 wt % magnesium, 0.03-0.2 wt % zirconium,

0.2-1.2 wt % manganese, up to 0.15 wt % silicon, 0.16-0.34 wt % scandium, 0-0.25 wt % copper, and optionally 0.05-0.5 wt % of a dispersoid-forming element selected from erbium, yttrium, gadolinium, holmium and hafnium, the balance being aluminum and unavoidable impurities. On a more preferred basis, the aluminum alloy composition contains about 3.5-6 wt % magnesium; about 0.06-0.12 wt % zirconium; about 0.4-1 wt % manganese, up to 0.08 wt % silicon and about 0.16-0.34 wt % scandium. Most preferably, the aluminum alloy composition consists essentially of about 3.8-5.2 wt % magnesium; about 0.09-0.12 wt % zirconium, about 0.5-0.7 wt % manganese, up to 0.05 wt % silicon and about 0.2-0.3 wt % scandium. Preferred embodiments of this aluminum alloy are also substantially zinc-free and lithium-free.

[0015] While not being limited to any particular theory, it is believed that this invention manages to impart significantly higher strengths and greater corrosion resistance to fuselage skin sheet stock through the addition of certain rare earths or rare earth "act-alikes", such as scandium, by causing rare earth-rich precipitates to form. These precipitates have the ability to store and resist loss of strength arising from plastic deformation. Because of the relatively small size and fine distribution of these particles, recovery and recrystallization of the resulting alloy are also inhibited.

[0016] The invention alloy is more temperature resistant than the same alloy devoid of scandium or scandium-like additives. By "temperature resistant", it is meant that a large portion of the strength and structure imparted by working this alloy is retained in the fuselage skin sheet end product, even after exposure to one or more higher temperatures, typically above about 232°C (450°F.), such as during subsequent rolling operations or the like.

[0017] When referring to the main alloying components of this invention, it is understood that a remainder of substantially aluminum may include some incidental, yet intentionally added elements which may affect collateral properties of the invention, or unintentionally added impurities, neither of which should change the essential characteristics of this alloy. With respect to the main alloying elements of this invention, it is believed that magnesium contributes to strain hardening and strength. Zirconium additions are believed to improve the resistance of scandium precipitates to rapid growth. Scandium and zirconium serve yet another purpose. When added to aluminum-magnesium alloys of the type described herein, scandium is believed to precipitate to form a dispersion of fine, intermetallic particles (referred to as "dispersoids"), typically of an Al_3X stoichiometry, with X being either Sc, Zr or both Sc and Zr. Al_3(Sc, Zr) dispersoids impart some strength benefit as a precipitation-hardening compound, but more importantly, such dispersoids efficiently retard or impede the process of recovery and recrystallization by a phenomenon sometimes called the "Zener Drag" effect. [See generally, C.S. Smith, TMS-AIMF, 175, 15(1948).] It is believed to result as follows: Scandium dispersoids are very small in size, but also large in number. They generally act as "pinning" points for migrating grain boundaries and dislocations which must bypass them for metal to soften. Recrystallization and recovery are the principal metallurgical processes by which such strain hardenable alloys soften. In order to "soften" an alloy having a large population of Al_3(Sc, Zr) particles, it is necessary to heat the material to higher temperatures than would be required for an alloy not having such particles. Put another way, when strain-hardened and annealed under identical conditions, a sheet product that contains Al_3(Sc, Zr) dispersoids will have higher strength levels than a comparable alloy to which no scandium was added.

[0018] For fuselage skin sheet stock and other aerospace applications, this invention exhibits an ability to resist softening during the high temperature thermal exposures usually needed to roll sheet products. In so doing, the invention alloy will retain some of the strength acquired through rolling. Other scandium-free alloys would tend to retain less strength through rolling, thus yielding a lower strength final product. An added benefit of zirconium is its ability to limit the growth of these Al_3X particles to assure that such dispersoids remain small, closely spaced and capable of producing a Zener Drag effect.

[0019] Although it is preferred to limit silicon in the aluminum alloy, it is inevitable that silicon from the refractory will be included. In commercial practice, over 80% of an alloy is obtained from scrap, thus adding to the presence of silicon. The alloy of this invention may contain up to 0.15 wt % silicon with up to 0.08 wt % being preferred and 0.05 wt % or less being most preferred.

[0020] In a similar manner, while copper is not an intentional elemental additive, it is a mildly soluble element with respect to this invention. As such, the alloy products described herein may accommodate up to about 0.25 wt % copper or preferably about 0.15 wt % Cu or less.

[0021] The aluminum alloy product of this invention is especially suited for applications where damage tolerance is required. Specifically, such damage tolerant aluminum products are used for aerospace applications, particularly fuselage skin, and the lower wing sections, stringers or pressure bulkheads of many airplanes.

[0022] The following example is provided to further illustrate the objectives and advantages of this invention. It is not intended to limit the scope of this invention in any manner, however.

EXAMPLE

[0023] This example refers to the following main additions to an aluminum based alloy of the present invention:

	Mg	Mn	Sc	Zr
Alloy A	4.0	---	0.23	0.10
Alloy B	4.1	0.62	0.23	0.09

with the balance of each alloy being aluminum, incidental elements and impurities.

[0024] All of the aforementioned alloys were direct chill (or "DC") cast as 2-1/2 x 12 inch ingots and the rolling surfaces scalped therefrom. Alloy A was not homogenized. Alloy B was homogenized for 5 hours at 287°C (550°F)followed by 5 hours at 427°C (800°F). The scalped ingots were heated to 287°C (550°F) for 30 minutes and cross rolled approximately 50% to a nominal thickness of 1 inch. Alloys A and B were then reheated to 287°C (550°F) and rolled to a final nominal thickness of 0.1 inch. Mechanical properties for each alloy were then evaluated after a stabilization treatment of 5 hours at 287°C (550°F).

[0025] Table I reports the physical, mechanical property and corrosion data available for the foregoing samples of Alloys A and B, then compares them with typical values for 2024-T3 aluminum, 6013-T6 aluminum and another potential fuselage skin material known commercially as Alcoa's C-188 product as manufactured in accordance with U.S. Patent No. 5,213,639.

[0026] The materials of this invention display adequate tensile strength properties. The toughness indicators of Alloy A and B, per center notch toughness and fatigue crack growth (or "FCG") data also strongly indicate that these materials will exhibit good inherent toughnesses as well. The resistance to grain boundary corrosion attack of the present invention is also noteworthy. A standard test for measuring such attacks in Al-Mg base alloys is the ASSET (or ASTM G-66) test after a "sensitization" treatment at 100°C (212°F). The subject materials demonstrated good resistance to exfoliation attack in that test with only Alloy B showing any evidence of exfoliation, and even then to just an EA level. By comparison, other materials showed some pitting attack (P) with minimal blistering. The invention materials also showed excellent SCC resistance during alternate immersion testing using an NaCl solution.

TABLE 1

Property	Alclad 2024-T3 Typicals	Alclad C-188 Typicals	6013-T6 Typicals	Alloy A	Alloy B
Strength MPa (ksi)					
UTS L	455 (66)	455 (66)	393 (57)	386 (56)	423 (61.4)
LT	448 (65)	393 (57)	393 (57)	379 (55)	416 (60.4)
45 > 472	>472 (>68.5)	---	---	352 (51)	383 (55.6)
TYS L	379 (55)	379 (55)	365 (53)	331 (48)	332 (48.2)
LT	310 (45)	310 (45)	352 (51)	338 (49)	337 (48.9)
45 > 348	> 348 (>50.4)	---	---	310 (45)	310 (45)
Elong. L	97 (14)	97 (14)		76 (11)	76 (11.0)
LT	124 (18)	124 (18)	76 (11)	110 (16)	112 (16.2)
45 > 145	>145 (>21)	---	---	152 (22)	130 (18.8)

Property	Alclad 2024-T3 Typicals	Alclad C-188 Typicals	6013-T6 Typicals	Alloy A	Alloy B
Density g/mm³ (lb/cu in)	0.280 (0.101)	0.277 (0.100)	0.271 (0.098)	0.265 (0.0958)	0.267 (0.0963)
Toughness MPa (ksi√in)			6" panel/16"	6" panel	6" panel
Kc T-L	---	---	118/147 (108/147)	100.5 (91.4)	107 (97.2)
Kapp T-L	---	---	68/94 (62/94)	666 (60.5)	69.1 (62.8)

Property	Alclad 2024-T3 Typicals	Alclad C-188 Typicals	6013-T6 Typicals	Alloy A	Alloy B
Fatigue					
Life at 172 MPa (25 ksi) (Kt=3; R=0.1)	---	---	3×10^4	3×10^4	2×10^4
DK at 10(-4) T-L	20	24	---	23/24	21
Modulus (Msi) Tension	10.6	10.6	9.9	10.1	10.4
Corrosion (after 1wk at 102°C (212°F))					
ASSET (24 hrs) ASTM G-66	EC	EC		PA	EA
Exco (96 hrs) ASTM G-34	ED	ED		N	---
MASTMASSIS (4 wks) ASTM G-85	ED	ED		N	---
SWAAT (2 wks) ASTM G-85	---	---		---	EC
SCC[1] ASTM G-47 (180 day exposure)	---	---		0/3	0/3

NOTE:

1. SCC: (# failures/# samples) Transverse Orientation, 75% Y.S. (after 1wk at 102°C (212°F))

[0027] It will be appreciated that an improved aluminum alloy for aerospace applications has been disclosed. This aluminum alloy has low density, good corrosion resistance and a good combination of strength and toughness by comparison to conventional fuselage skin materials.

Claims

1. An aluminum alloy product comprising an alloy composition consisting essentially of 3.5-6 wt % magnesium, 0.03-0.2 wt % zirconium, 0.2-1.2 wt % manganese, up to 0.15 wt % silicon, 0.16-0.34 wt % scandium, 0-0.25 wt % copper, and optionally 0.05-0.5 wt % of a dispersoid-forming element selected from erbium, yttrium, gadolinium, holmium and hafnium, the balance being aluminum and unavoidable impurities.

2. The aluminum alloy product of claim 1, wherein said alloy contains 0.2-0.3 wt % scandium.

3. The aluminum alloy product of claim 1, wherein said alloy is substantially zinc-free and lithium-free.

4. A damage tolerant, aerospace part having low density, good corrosion resistance and a good combination of strength and toughness, said aerospace part being made from an alloy composition consisting essentially of 3.5 to 6 wt % magnesium; 0.03-0.2 wt % zirconium; 0.2-1.2 wt % manganese; up to 0.15 wt % silicon; 0.16-0.34 wt % scandium; 0-0.25 wt % copper and optionally 0.05-0.5 wt % of a dispersoid-forming element selected from erbium, yttrium, gadolinium, holmium and hafnium, the balance being aluminum and unavoidable impurities.

5. The aerospace part of claim 4, which is selected from fuselage skin, a lower wing section, a stringer and a pressure bulkhead.

6. The aerospace part of claim 5, wherein said dispersoid-forming element consists essentially of scandium.

7. The aerospace part of claim 6, wherein said alloy composition contains 0.2-0.3 wt % scandium.

8. An aluminum alloy product or an aerospace part according to any of the preceding claims, wherein said alloy composition contains 3.8-5.2 wt % magnesium.

9. An aluminum alloy product or an aerospace part according to any of the preceding claims, wherein said alloy composition contains a maximum of 0.25 wt % copper.

10. An aluminum alloy product or an aerospace part according to any of the preceding claims, wherein said alloy composition contains 0.06-0.12 wt % zirconium.

11. An aluminum alloy product or an aerospace part according to any of the preceding claims, wherein said alloy composition contains 0.09-0.12 wt % zirconium.

12. An aluminum alloy product or an aerospace part according to any of the preceding claims, wherein said alloy composition contains 0.4-1 wt % manganese.

13. An aluminum alloy product or an aerospace part according to any of the preceding claims, wherein said alloy composition contains 0.5-0.7 wt % manganese.

14. An aluminum alloy product or an aerospace part according to any of the preceding claims, wherein said alloy composition contains up to 0.08 wt % silicon.

15. An aluminum alloy product or an aerospace part according to any of the preceding claims, wherein said alloy composition contains up to 0.05 wt % silicon.

16. The aerospace part of claim 5, wherein said alloy composition is substantially zinc-free.

17. The aerospace part of claim 5 or 6, wherein said alloy composition is substantially lithium-free.

18. An aluminum alloy product according to claim 1 or an aerospace part according to claim 6, wherein said alloy

composition contains 3.5-6 wt % magnesium, 0.06-0.12 wt % zirconium, 0.4-1 wt % manganese, up to 0.08 wt % silicon and 0.16-0.34 wt % scandium.

19. An aluminum alloy product according to claim 1 or an aerospace part according to claim 6, wherein said alloy composition contains 3.8-5.2 wt % magnesium, 0.09-0.12 wt % zirconium, 0.5-0.7 wt % manganese, up to 0.05 wt % silicon and 0.2-0.3 wt % scandium.

Patentansprüche

1. Aluminiumlegierungsprodukt, aufweisend eine Aluminiumzusammensetzung, im Wesentlichen bestehend aus: 3,5% -6 Gew.% Magnesium, 0,03% - 0,2 Gew.% Zirconium, 0,2% -1,2 Gew.% Mangan, bis zu 0,15 Gew.% Silicium, 0,16 % - 0,34 Gew.% Scandium, 0%-0,25 Gewichtsprozent Kupfer und wahlweise 0,05% -0,5 Gew.% eines Dispersoid-bildenden Elements, ausgewählt aus: Erbium, Yttrium, Gadolinium, Holmium und Hafnium; wobei der Rest Aluminium sowie unvermeidbare Verunreinigungen sind.

2. Aluminiumlegierungsprodukt nach Anspruch 1, bei welchem die Legierung 0,2% - 0,3 Gew.% Scandium enthält.

3. Aluminiumlegierungsprodukt nach Anspruch 1, bei welchem die Legierung im Wesentlichen frei ist von Zink und Lithium.

4. Schadentolerantes Teil für Luft- und Raumfahrt mit niedriger Dichte, guter Korrosionsbeständigkeit und guter Kombination von Festigkeit und Schlagzähigkeit, wobei das Teil für Luft- und Raumfahrt hergestellt wird aus einer Legierungszusammensetzung, im Wesentlichen bestehend aus: 3,5% - 6 Gew.% Magnesium, 0,03% - 0,2 Gew. % Zirconium, 0,2%- 1,2 Gew.% Mangan, bis zu 0,15 Gew.% Silicium, 0,16% - 0,34 Gew.% Scandium, 0% - 0,25 Gew.% Kupfer und wahlweise 0,05% - 0,5 Gew.% eines Dispersoid-bildenden Elements, ausgewählt aus: Erbium, Yttrium, Gadolinium, Holmium und Hafnium; wobei der Rest Aluminium sowie unvermeidbare Verunreinigungen sind.

5. Teil für Luft- und Raumfahrt nach Anspruch 4, wobei das Teil ausgewählt wird aus Rumpfschale, einem unteren Tragflächenprofil, einer Längsversteifung und einem Druckspant.

6. Teil für Luft- und Raumfahrt nach Anspruch 5, bei welchem das Dispersoid-bildende Element im Wesentlichen aus Scandium besteht.

7. Teil für Luft- und Raumfahrt nach Anspruch 6, bei welchem die Legierungszusammensetzung 0,2% - 0,3 Gew.% Scandium enthält.

8. Aluminiumlegierungsprodukt oder Teil für Luft- und Raumfahrt nach einem der vorgenannten Ansprüche, bei welchen die Legierungszusammensetzung 3,8% - 5,2 Gew.% Magnesium enthält.

9. Aluminiumlegierungsprodukt oder Teil für Luft- und Raumfahrt nach einem der vorgenannten Ansprüche, bei welchen die Legierungszusammensetzung maximal 0,25 Gew.% Kupfer enthält.

10. Aluminiumlegierungsprodukt oder Teil für Luft- und Raumfahrt nach einem der vorgenannten Ansprüche, bei welchen die Legierungszusammensetzung 0,06% - 0,12 Gew.%. Zirconium enthält.

11. Aluminiumlegierungsprodukt oder Teil für Luft- und Raumfahrt nach einem der vorgenannten Ansprüche, bei welchen die Legierungszusammensetzung 0,09% - 0,12 Gew.% Zirconium enthält.

12. Aluminiumlegierungsprodukt oder Teil für Luft- und Raumfahrt nach einem der vorgenannten Ansprüche, bei welchen die Legierungszusammensetzung 0,4% - 1 Gew.% Mangan enthält.

13. Aluminiumlegierungsprodukt oder Teil für Luft- und Raumfahrt nach einem der vorgenannten Ansprüche, bei welchen die Legierungszusammensetzung 0,5% - 0,7 Gew.% Mangan enthält.

14. Aluminiumlegierungsprodukt oder Teil für Luft- und Raumfahrt nach einem der vorgenannten Ansprüche, bei welchen die Legierungszusammensetzung bis zu 0,08 Gew.% Silicium enthält.

15. Aluminiumlegierungsprodukt oder Teil für Luft- und Raumfahrt nach einem der vorgenannten Ansprüche, bei welchen die Legierungszusammensetzung bis zu 0,05 Gew.%. Silicium enthält.

16. Teil für Luft- und Raumfahrt nach Anspruch 5, bei welchem die Legierungszusammensetzung im Wesentlichen frei ist von Zink.

17. Teil für Luft- und Raumfahrt nach Anspruch 5 oder 6, bei welchem die Legierungszusammensetzung im Wesentlichen frei von Lithium ist.

18. Aluminiumlegierungsprodukt nach Anspruch 1 oder Teil für Luft- und Raumfahrt nach Anspruch 6, bei welchen die Legierungszusammensetzung enthält: 3,5% - 6 Gew.% Magnesium, 0,06% - 0,12 Gew.% Zirconium, 0,4% - 1 Gew.% Mangan, bis zu 0,08 Gew.% Silicium und 0,16% - 0,34 Gew.% Scandium.

19. Aluminiumlegierungsprodukt nach Anspruch 1 oder Teil für Luft- und Raumfahrt nach Anspruch 6, bei welchen die Legierungszusammensetzung enthält: 3,8% - 5,2 Gew.% Magnesium, 0,09% - 0,12 Gew.% Zirconium, 0,5% - 0,7 Gew.% Mangan, bis zu 0,05 Gew.% Silicium und 0,2% - 0,3 Gew.% Scandium.

Revendications

1. Produit d'alliage d'aluminium comprenant une composition d'alliage constituée essentiellement de 3,5 - 6% en poids de magnésium, 0,03 - 0,2% en poids de zirconium, 0,2 - 1,2% en poids de manganèse, jusqu'à 0,15% en poids de silicium, 0,16 - 0,34% en poids de scandium, 0 - 0,25% en poids de cuivre, et en option 0,05 - 0,5% en poids d'un élément formant un dispersoïde choisi parmi l'erbium, l'yttrium, le gadolinium, l'holmium et l'hafnium, le reste étant l'aluminium et des impuretés inévitables.

2. Produit d'alliage d'aluminium selon la revendication 1, dans lequel ledit alliage contient 0,2 - 0,3% en poids de scandium.

3. Produit d'alliage d'aluminium selon la revendication 1, dans lequel ledit alliage est sensiblement exempt de zinc et exempt de lithium.

4. Partie aérospatiale résistant aux endommagements, ayant une faible densité, une bonne résistance à la corrosion et une bonne combinaison de la résistance mécanique et de la dureté, ladite partie aérospatiales étant constituée d'une composition d'alliage consistant essentiellement de 3,5 à 6% en poids de magnésium, 0,03 - 0,2% en poids de zirconium, 0,2 - 1,2% en poids de manganèse, jusqu'à 0,15% en poids de silicium, 0,16 - 0,34% en poids de scandium, 0 - 0,25% en poids de cuivre et en option 0,05 - 0,5% en poids d'un élément formant un dispersoïde choisi parmi l'erbium, l'yttrium, le gadolinium, l'holmium et l'hafnium, le reste étant l'aluminium et des impuretés inévitables.

5. Partie aérospatiale selon la revendication 4, qui est choisie parmi une peau de fuselage, des sections d'ailes inférieures, des arêtes et/ou des cloisons sous pression.

6. Partie aérospatiale selon la revendication 5, dans laquelle ledit élément formant un dispersoïde consiste essentiellement en scandium.

7. Partie aérospatiale selon la revendication 6, dans laquelle ladite composition d'alliage contient 0,2 - 0,3% de scandium.

8. Produit d'alliage d'aluminium ou partie aérospatiale selon l'une quelconque des revendications précédentes, dans lequel ladite composition d'alliage contient 3,8-5,2% en poids de magnésium.

9. Produit d'alliage d'aluminium ou partie aérospatiale selon l'une quelconque des revendications précédentes, dans lequel ladite composition d'alliage contient un maximum de 0,25% en poids de cuivre.

10. Produit d'alliage d'aluminium ou partie aérospatiale selon l'une quelconque des revendications précédentes, dans lequel ladite composition d'alliage contient 0,06 - 0,12% de zirconium.

11. Produit d'alliage d'aluminium ou partie aérospatiale selon l'une quelconque des revendications précédentes, dans lequel ladite composition d'alliage contient 0,09 - 0,12% en poids de zirconium.

12. Produit d'alliage d'aluminium ou partie aérospatiale selon l'une quelconque des revendications précédentes, dans lequel ladite composition d'alliage contient 0,4 - 1% en poids de manganèse.

13. Produit d'alliage d'aluminium ou partie aérospatiale selon l'une quelconque des revendications précédentes, dans lequel ladite composition d'alliage contient 0,5 - 0,7% en poids de manganèse.

14. Produit d'alliage d'aluminium ou partie aérospatiale selon l'une quelconque des revendications précédentes, dans lequel ladite composition d'alliage contient jusqu'à 0,08% en poids de silicium.

15. Produit d'alliage d'aluminium ou partie aérospatiale selon l'une quelconque des revendications précédentes, dans lequel ladite composition d'alliage contient jusqu'à 0,05% en poids de silicium.

16. Partie aérospatiale selon la revendication 5, dans laquelle ladite composition d'alliage est sensiblement exempte de zinc.

17. Partie aérospatiale selon la revendication 5 ou 6, dans laquelle ladite composition d'alliage est sensiblement exempte de lithium.

18. Produit d'alliage d'aluminium selon la revendication 1 ou partie aérospatiale selon la revendication 6, dans lequel ladite composition d'alliage contient 3,5 - 6% en poids de magnésium, 0,06 - 0,12% en poids de zirconium, 0,4 - 1% en poids de manganèse, jusqu'à 0,08% en poids de silicium et 0,16 - 0,34% en poids de scandium.

19. Produit d'alliage d'aluminium selon la revendication 1 ou partie aérospatiale selon la revendication 6, dans lequel ladite composition d'alliage contient 3,8 - 5,2% en poids de magnésium, 0,09 - 0,12% en poids de zirconium, 0,5-0,7% en poids de manganèse, jusqu'à 0,05% en poids de silicium et 0,2- 0,3% en poids de scandium.